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COLLINS RADIO COMPANY

Cedar Rapids, Iowa

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PRELIMINARY SPECIFICATION  
FOR  
THE LUNAR SOUNDER HF TRANSMITTER-RECEIVER

11 DECEMBER 1970

COLLINS RADIO COMPANY  
CEDAR RAPIDS, IOWA

## SECTION I

### SCOPE

1.1 This specification covers one type of equipment designated as Lunar Sounder HF Transmitter-Receiver, Collins Type No. TBA . A conjunction with the Lunar Sounder Timer, Collins Type No. TBA and the Lunar Sounder Antenna assembly Collins Type No. TBA , the equipment will provide for the transmission of RF pulses to the lunar surface from an orbiting vehicle and for the reception of the reflected pulses.

SECTION II  
APPLICABLE DOCUMENTS

2.1 General

The following documents form a part of this specification to the extent specified herein.

Specifications  
Collins Radio Company  
TBD

Acceptance Test Procedure for the  
Lunar Sounder HF Transmitter-Receiver,  
Design Proof Test Procedure for the  
Lunar Sounder HF Transmitter-Receiver,

TBD

North American Rockwell  
SD 69-315

Apollo Lunar Exploration Missions Experiment  
Instruments Performance and Interface Spec-  
ification Block II-CSM 22 December 1969,

2.2 Precedence

When the requirements of this specification or any other contractual document are in conflict, precedence shall be as specified in SD69-315.

## SECTION III

### REQUIREMENTS

#### 3.1 Components

The Lunar Sounder HF Transmitter-Receiver shall consist of components mounted on a common chassis.

#### 3.2 General Specification

The requirements of SD69-315 shall apply as requirements of this specification with the exceptions and additions specified herein.

#### 3.3 Selection of Specifications and Standards

Specifications and standards shall be selected in accordance with specification SD69-315.

#### 3.4 Materials

Materials shall conform to the requirements of specification SD69-315.

#### 3.5 Design

The equipment shall provide for the transmission of short pulses of RF energy centered on the assigned center frequency.

It shall have the capability of detecting the transmitted pulses after they have been attenuated and delayed by reflection from a distant surface, and providing the detected signals as an RF output offset from the transmitted frequency at a nominal 455 kHz.

Provisions shall be incorporated to provide reference outputs in synchronism with the transmitted pulses, and inhibit circuitry shall be provided to enable the unit to operate sequentially with another unit of the same general characteristics.

##### 3.5.1 Frequency Assignments

The assigned center frequencies shall be as follows:

-001	5 MHz
-002	15 MHz

### 3.6 Construction

The equipment shall be constructed by modifying a Collins HF Transceiver, Type No. 514-0016.

### 3.7 Performance

#### 3.7.1 Power Source

The equipment shall operate from a 28-volt dc source having the characteristics specified in SD 69-315.

#### 3.7.2 Power Input Requirements

The average power required by the equipment shall not exceed 12 watts.

#### 3.7.3 Transmitter RF Power Output

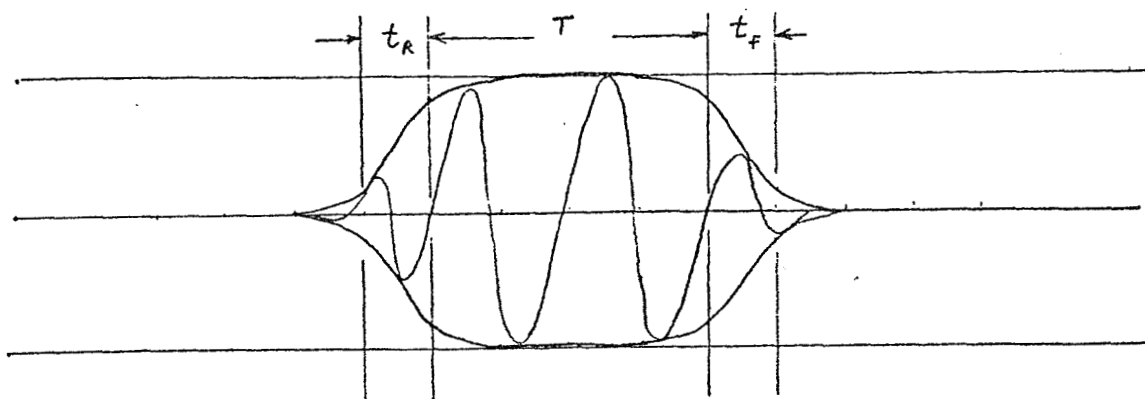
The peak envelope power output of the transmitter shall be no less than the value listed below when operated into a 50-ohm resistive load:

-001            45 watts

-002            20 watts

#### 3.7.4 Transmitter RF Pulse Envelope

When operated into the loads specified in paragraph 3.7.3 the envelope of the RF output pulse shall fall within the limits shown in figure 1. The transmit Sync pulse shall be coherent with the leading edge of the RF pulse generated such that the variation of the pulse leading edge relative to the any selected zero crossing of the reply as it appears at the video output terminal (455 KHz) does not deviate greater than  $\pm 5$  nanoseconds in any one second period for any fixed delay introduced into the transmitted RF output which results in a receiver input during the specified receive period.



-001      $t_R = \text{NMT } \underline{0.8} \text{ microseconds}$   
           $t_f = \text{NMT } \underline{0.8} \text{ microseconds}$   
           $T = \underline{2.2} \pm \underline{0.2} \text{ microseconds}$

-002      $t_r = \text{NMT } \underline{0.5} \text{ microseconds}$   
           $t_f = \text{NMT } \underline{0.5} \text{ microseconds}$   
           $T = \underline{1.1} \pm \underline{0.1} \text{ microseconds}$

FIGURE 1

### 3.7.5 Pulse Timing

When primary power is applied to the unit, it shall (in the absence of the received inhibit sync pulses as described in paragraph 3.7.15) transmit inhibit sync pulses and rf pulses at intervals of  $2290 \pm 10$  microseconds. The rf pulses shall occur  $255 \pm 5$  microseconds subsequent to the leading edge of the transmit inhibit sync pulse and shall be of duration specified in paragraph 3.7.4. The transmit inhibit sync pulse shall be in accordance with paragraph 3.7.15.

If a receive inhibit sync pulse is present at the Sync terminal, a transmit sync pulse shall be initiated  $2000 \pm 10$  microseconds subsequent to the leading edge of the received inhibit sync pulse and be followed at the appropriate time by the rf pulse transmission. No other output pulses shall occur subsequent to that time.

### 3.7.6 Transmitter Frequency Stability

The center frequency of the rf output (CW) shall not vary more than 5 ppm from the assigned center frequency. The rms phase jitter measured over any 1 second period shall not exceed TBD degrees.

### 3.7.7 Transmitter Spurious Outputs

All antenna conducted rf outputs from the transmitter, other than those produced by the fundamental carrier frequency and the sidebands produced by the modulating pulses, shall be no greater than TBD dbm.

### 3.7.8 Receive Period

The receive period is defined as starting 300 microseconds after the transmitted pulse falls to its 10 percent value and extending for one millisecond. The receiver is required to meet its specified performance only during this period.

### 3.7.9 Receiver Source Impedance

The nominal impedance of the source feeding the receiver (during the receive period) will be 50 ohms.

### 3.7.10 Receiver Input Impedance

The nominal input impedance of the receiver (during the receive period) shall be 50 ohms.

### 3.7.11 Receiver Frequency Translation

The receiver shall translate rf input signals in such a manner that the receiver output frequency is  $[455 \text{ kHz} + |f_{\text{inputs}} - f_c|]$  within 5 ppm of  $f_c$ , where  $f_c$  is the assigned center frequency specified in Section 3.5.1. With a fixed input frequency, the output frequency shall not vary more than 1.5 ppm in any 2-second period.

### 3.7.12 Video Output

The unit shall provide a video output consisting of the combined receiver output and transmit sync pulse. This output, provided from a coaxial connector, shall meet the specified requirements when terminated in a load of 50 ohms  $\pm 10\%$  resistive over the band of 100 kHz to 2 MHz.

#### 3.7.12.1 Receiver Output

The receiver output as described in paragraph 3.7.11 shall time share the video output with the transmit sync pulse. Receiver noise shall be suppressed during the transmit sync pulse to a level not greater than -30 dbm.

With the AGC stabilized the receiver output level as measured at the video output terminal shall be 1 volt  $\pm 10\%$  peak to peak for a reference rf input signal of peak envelope power between -90 dbm and -40 dbm.

#### 3.7.12.2 Transmit Sync Pulse Output

The transmit sync pulse shall time share the video output with the receiver. The pulse shall occur synchronous with the rf modulated output

and shall be present at the video output terminal within  $\pm 1$  microsecond of the pulsed rf output. The displacement between the leading edge of the sync pulse and any selected zero crossing of the received IF shall not deviate by more than  $\pm 5$  nanoseconds in any 1 second period for any fixed delay.

Transmit sync pulses from the video output shall be 5 microseconds  $\pm 20\%$  duration. The pulse shall be positive going of a level of 1 volt  $\pm 10\%$  peak for the -001 configuration and negative going of a level of 1 volt  $\pm 10\%$  peak for the -002 configuration.

#### 3.7.13 Receiver Pulse Response

With an input consisting of 5 microsecond wide pulses of rf on the assigned center frequency and having a repetition rate of 500 pps the rise and fall times of the output pulses (90% - 10%) shall not exceed 1.2 microseconds. This requirement shall be met with rf input levels up to -40 dbm after the AGC has stabilized.

### 3.7.14 Receiver AGC

#### 3.7.14.1 Attack Time

With an initial steady-state reference input (see note 6.2) from -90 dbm to -40 dbm, the output signal shall recover to within 110 percent of the new steady-state value in 10,000 microseconds after the application of a 10 db step increase in the RF input level.

#### 3.7.14.2 Release Time

With an initial steady-state reference input (see note 6.2) from -90 dbm to -40 dbm, the output signal shall recover to within 90 percent of the new steady-state value in 1 second after the application of a 10 db step decrease in the RF input level.

### 3.7.15 Timing Sync

Terminals accommodating a twisted shielded wire pair shall be provided for the transmission and reception of Sync signals. Nominal input impedance shall be 470 ohms shunted by not more than 30 picofarads capacitance. Sync signals generated by the unit for transmission shall be characterized by the establishment of a ground (zero  $\pm 0.5$ , -0.0 volts dc) capable of sinking not less than 12 milliamperes. Sync signals shall exhibit rise and fall times (10% to 90% amplitude) of not greater than 1 microsecond with a test load of 470 ohms shunted by 200 picofarads capacitance. A transmit Sync pulse shall be initiated  $265 \pm 5$  microseconds prior to R-F transmission and shall remain for a duration of 5 microseconds.

### 3.7.15 Timing Sync (Cont.)

Transmit/receive inhibit sync pulses shall be accepted at the sync terminal and are characterized by the establishment of a ground (zero +0.5, -0.0 volts dc) capable of sinking not less than 12 milliamperes. Inhibit sync pulses shall be of a duration of  $300 \pm 5$  microseconds. Upon receipt of the inhibit sync pulse the unit shall (1) inhibit reception by the receiver for a period of  $300 \pm 10$  microseconds and (2) inhibit transmission of the transmit sync pulse for a period of not less than 1980 microseconds or not greater than 2000 microseconds referenced to the leading edge of the inhibit sync pulse.

### 3.8 Telemetry Outputs

Telemetry outputs shall be provided for the functions listed below. Each of these outputs shall be normalized to provide nominal 0 to 5 volt signals into a 5000 ohm load. These signals shall be sampled once per second. Calibration curves shall be provided for each output.

#### 3.8.1 RF Output

An output shall be provided which is proportional to the peak output power of the transmitter. The scale factor shall be as follows:

-001 +5 V corresponds to a nominal power output of 50 W PEP

-002 +5 V corresponds to a nominal power output of 25 W PEP

#### 3.8.2 AGC Voltage

An output shall be provided which is proportional to receiver AGC voltage. 0-to +5 V shall correspond to a nominal signal strength of -90 to -40 dbm.

#### 3.8.3 Internal Temperature

An output shall be provided which is proportional to the hot spot temperature of the transceiver. 0 to +5 V shall correspond to 0°C to +70°C.

### 3.9 Interchangeability

The interchangeability shall be in accordance with the requirements of specification SD69-315.

### 3.10 Electromagnetic Interference

The equipment shall meet the electromagnetic interference requirement of specification SD69-315 with the following exception TBD .

### 3.11 Finish

The equipment shall be finished in accordance with the requirement of specification SD69-315.

### 3.12 Identification of Product

The equipment shall be marked as specified in specification SD69-315.

SECTION IV  
QUALITY ASSURANCE PROVISIONS

4.1 Classification of Tests

The inspection and testing of the Lunar Sounder HF Transmitter-Receiver shall be classified as follows:

- (1) Design Proof Tests
- (2) Acceptance Tests

4.2 Design Proof Tests

The equipment shall meet the performance requirements specified herein during the tests specified in Tables 4-1 and 4-2 when subjected to the environment levels and test methods specified in SD69-315 and the Design Proof Test Procedure for the Lunar Sounder HF Transmitter-Receiver.

4.3 Acceptance Tests

Each equipment shall meet the requirement specified herein during the tests specified in Table 4-3. The environment levels and test methods shall be in accordance with specification SD69-315 and the Acceptance Tests Procedure for the Lunar Sounder HF Transmitter-Receiver.

TABLE 4-1 DESIGN PROOF TESTING REQUIREMENTS

TEST	TEST SPECIMEN	
	#1	#2
Acceptance Test (Ref.)	X	X
Humidity/Salt Atmosphere	X	
Vibration	X	
Acceleration	X	
Shock	X	
Thermal Vacuum	X	
Explosive Atmosphere	X	
Mission Simulation		X

TABLE 4-2 DESIGN PROOF TESTS

TEST	Acceptance Test (Ref.)	Humidity/Salt Atmosphere	Vibration	Acceleration	Shock	Thermal Vacuum	Explosive Atmosphere	Mission Simulation	Functional
Input Power	X	X	X			X	X	X	X
Trans. Pk Env. Pwr (50 $\Omega$ )	X	X				X		X	X
Trans. Pk Env. Pwr (2:1 VSWR)	X	X				X		X	X
Trans. rf Pulse Characteristics	X	X				X		X	X
Trans. Sync Pulse Stability	X	X				X		X	X
Trans. Noise Level	X	X				X		X	X
Trans. prf (Unsynchronized)	X	X		Non-operating	Non-operating	X		X	X
Trans. prf (Synchronized)	X	X				X		X	X
T/R Freq. Stability	X	X				X		X	X
Rec. Sensitivity	X	X				X		X	X
Rec. Selectivity	X	X				X		X	X
Rec. Dynamic Range	X	X				X		X	X
Rec. AGC Characteristics	X	X				X		X	X
Video Output Level	X	X				X		X	X
Video Output Noise Level	X	X				X		X	X
High and Low Voltage	X	X				X		X	X

- 1) The test specimen shall be subject to the Functional Tests before and after each environmental test.
- 2) Tests indicated by an X shall be performed during the tests indicated.

TABLE 4-3  
ACCEPTANCE TESTS

- (a) Mechanical Inspection
- (b) Electrical Tests. To be performed at room ambient conditions.
  - (1) Input Power
  - (2) Transmitter Peak Envelope Power
  - (3) Transmitter rf Pulses Characteristic
  - (4) Transmitter Sync Pulse Stability
  - (5) Transmitter Noise Level
  - (6) Transmitter PRF (unsynchronized)
  - (7) Transmitter PRF (synchronized)
  - (8) Transmitter-Receiver Frequency Stability
  - (9) Receiver Sensitivity
  - (10) Receive dynamic range
  - (11) Receiver AGC Characteristics
  - (12) Video Output Level
  - (13) Video Output Noise Level
  - (14) Single Point Ground Isolation
- (c) Burn-in Tests. To be performed before and after burn-in.
  - (1) All tests b (1) through b (14).
- (d) To be performed at 24 hours during burn-in
  - (1) Input Power
  - (2) Transmitter Peak Envelope Power
  - (3) Transmitter PRF (unsynchronized)
  - (4) Transmitter-Receiver Frequency Stability
  - (5) Receiver Sensitivity
  - (6) Video Output Level.

(e) Vibration Tests

- (1) Input Power
- (2) Transmitter Peak Envelope Power
- (3) Transmitter rf Pulse Characteristics
- (4) Transmitter PRF (unsynchronized)
- (5) Transmitter Sync Pulse Stability
- (6) Receiver Sensitivity
- (7) Video Output Level

(f) Thermal Tests

- (1) All tests b(1) through b(14).

SECTION V  
PREPARATION FOR DELIVERY

5.1      General Requirements

The equipment shall be preserved and packaged in accordance with specification SD69-315.

## SECTION VI

### NOTES

#### 6.1 Dash Numbers

All dash numbers in this specification, i.e., -001, -002, etc., consist of all paragraphs. Where a paragraph is subdivided by dash numbers, only that part preceded by the specific dash number shall apply.

#### 6.2 Reference Inputs

The reference inputs shall consist of a train of pulses with a repetition rate of 500 pps, with each pulse having the waveform specified in Section 3.7.4. When the power level of the reference input is specified, it is defined as the peak envelope power of the pulse.

